DEPARTMENT OF APPLIED ECONOMICS

RESEARCH REPORT

# UNDERSTANDING NEW VENTURE MARKET APPLICATION SEARCH PROCESSES: A PROPOSITIONAL MODEL

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## Abstract

Technology-based ventures are confronted with complex decisions on how to apply their technology platform in highly uncertain and ambiguous market environments. Based on four case studies, a dynamic decision model is developed in which we highlight the similarities between the search and learning processes in venture development contexts and in new product development contexts. This entrepreneurial search and learning process is understood as consisting of sequences of episodes – characterized by uncertainty and ambiguity - and scripts – i.e. approaches to market application search. The model implies that a venture's adaptability - i.e. its ability to move efficiently and effectively between these episodes and their related scripts - influences its survival.

## I. Stating the issue: the importance of 'searching' and 'learning' in new venture development

Mortality rates among new ventures are known to be high. About 40% of them fail in the first year of their existence. About 50% of them fail in the first three years. About 60% of them fail in the first six years, about 70% in the first eight years, and about 90% during the first ten years (see, amongst others: Timmons, 1994; Smilor and Gill, 1986; Bruno et al., 1992: EC, 1993; Cooper et al., 1994; Bhidé, 2000). In addition, many 'surviving' firms attain only 'marginal survival.' This phenomenon of firm failure and marginal survival explains why the tails of firm size distributions are so long, populated as they are with a multitude of small firms continuously entering an industry while failing to grow and to prosper in the longer run.

It has indeed been shown that new ventures are characterized by: (1) liabilities of smallness (see for example: Hannan and Freeman, 1977; Singh and Lumsden, 1990; Barron et al, 1994; Haveman, 1993), (2) liabilities of newness (see: Stinchcombe, 1965; Shepherd et al., 2000; and for an overview see: Eisenhardt and Schoonhoven, 1990), and also - when trying to internationalize their activities – (3) liabilities of foreignness (Hymer, 1976; Lu and Beamish, 2001). These liabilities – all referring to a potential lack of resources, capabilities or knowledge – will hinder ventures in coping with the **uncertainty and ambiguity** as to their viable market configurations, especially in the case of new technology-based ventures (or NTVs) confronted with high degrees of both technical and market newness. Uncertainty is defined as characteristic of a situation in which the problem solver understands the structure of the problem (including the set of relevant decision variables), but is dissatisfied with the knowledge available on the value of these decision variables (Schrader et al., 1993). Ambiguity is then defined as lack of clarity regarding the relationships between the variables and the problem solving algorithm and sometimes even about the set of relevant decision variables itself. Ambiguity relates directly to Daft and Lengel's notion (1986) of equivocality, which they define as *"... ambiguity, the existence of multiple and conflicting interpretations about a situation."* Certainly during the early stages in its life, a technology-based venture is confronted with high degrees of both uncertainty and ambiguity while confronted with a limited knowledge base and experiencing restricted access to resources (see for example: Bhidé, 2000). Innovations are by definition only successful when they succeed in coupling a technological capability to a user need (Teubal et al., 1991). During this process, innovations face considerable selection pressures on their

way to commercialisation (Nelson and Winter, 1982). Not only is the nature and the outcome of their technical activities inherently unpredictable (Steensma et al., 2000), but also the market selection and commercialisation process itself poses problems of uncertainty and ambiguity (Chesbrough, 2003). Utterback (1987) therefore distinguishes between technical and target uncertainty. Entrepreneurs continuously ask what application they want to strive for and what competencies they need to develop in order to accomplish that prowess (Bhidé, 1996). In emergent markets, technological options are at best marginally understood, distribution channels and sources of supply are problematic, market needs are not clearly defined, business models to a large extent absent, and hence, market viability cannot be proven a priori. It is therefore not astonishing that most initial selections of market applications by new ventures have to be abandoned later on (Tegarden et al., 1999 ; Chesbrough, 2003; Chesbrough & Rosenbloom, 2002).

It is the aim of this paper to advance our insight into the process of selecting a viable market application. We argue that (P1) NTVs need to be able to address both uncertainty and ambiguity regarding market application selection; and (P2) the existing life-cycle literature does not adequately explain this selection process. Combining insights from New Product Development literature and in depth cases studies, we propose that (P3) different episodes/forms of uncertainty and ambiguity can be discerned within one and the same entrepreneurial trajectory albeit not necessarily in a linear manner. For each of these episodes/forms, there exists a most appropriate approach to market application search. Furthermore, we propose that (P4) a venture's survival is dependent on its 'adaptability', i.e. its ability to move efficiently and effectively between these episodes and their related scripts.

Following Shane and Eckhardt (2003), we limit our focus to ventures that pursue the independent exploitation of a specific technology platform. These authors identify four types of entrepreneurial efforts (independent start-up, spin-off, acquisition and corporate venturing) as a function of the locus of discovery and exploitation, depending on whether the entrepreneur is an independent individual or a member of an existing organization. Given the propositions of this paper, we limit attention to independent start-ups and spin-offs.

## II. A closer look at the new venture survival and growth literature

### *II.1. Stage-based approaches: a summary of insights*

Numerous studies (for an overview see: Bamford et al., 1999; Reynolds and Miller, 1992 or Vesper, 1990) suggest that ventures 'change' over their life. In this respect, the search for viable market applications can be considered as a process that evolves over time. For example, Stevenson and Gumpert (1985) suggest that commitment to market applications should be developed in stages. A similar idea is developed by Tegarden et al. (1999), who state that once a dominant design emerges in the market, ventures should adopt this dominant design in order to become successful (see also Suarez and Utterback, 1995). Before the dominant market application crystallises, the company should adopt a flexible and adaptive approach to markets. Inexpensive experimental products and services should be launched (see Eisenhardt et al. various studies 1995 & 1997). According to Berry and Taggart (1998), during the early stages of its life, the venture should merely focus on identifying profitable markets for its technology. Later on, R&D efforts will become market-driven and targeted at already identified market opportunities. Bhidé (1992) elaborates further on the market aspect. This also means we can and should discern between 'early' customers and customers that are targeted during the later stages of the NTV's life. Geoffrey Moore (1995, 1999) makes this issue highly explicit in his books *Crossing the Chasm* and *Inside the Tornado*. Entrepreneurial and managerial approaches have also been hypothesized to be phase-related. Stevenson et al. (1989) suggest that management evolves from entrepreneurial to more professional. This occurs for various managerial aspects, such as: (1) the planning and the development of organizational procedures and routines (see for example: Bhidé, 1992, 1996 & 2000; Berry and Taggart, 1998), (2) the acquisition of resources (Bhidé, 1992, 2000; Churchill and Lewis, 1983), and (3) networking (Hite and Hesterly, 2001; DeBresson and Amesse, 1991).

### *II.2. Stage-based models and life-cycle models*

Since the search, learning and decision process appears to consist of different phases and concomitant approaches, one might expect the lifecycle literature to provide additional insights. For a review of the lifecycle literature, we refer to Hanks at al. (1993) or Kazanjian and Drazin (1989 & 1990). However, when analyzing lifecycle models, we are forced to conclude that they do not really focus on the processes by which an NTV selects and adopts its market

application(s). As shown by Churchill and Lewis (1983), most models do not pay much attention to the initial stages of a company's life. Even models that withstand this critique can be shown to have two major limitations.

Limitation 1: Linearity of the models

Quite a number of empirical studies obtained results that support the lifecycle view (see for example: Miller and Friesen, 1984; Hanks et al., 1993; Kazanjian and Drazin, 1989; Roure and Keeley, 1990, Hansen and Bird, 1997). Other authors, however, have argued that the linear idea of a uni-directional sequence of life stages is too simplistic (e.g. Tornatzky et al., 1983; Utterback, 1987). They therefore suggest that multiple paths through and towards these stages exist (e.g. Adizes, 1979). Reynolds and Miller (1992) and Gersick (1994) have confirmed the stochastic nature of a firm's adaptive processes.

Autio (1997) proposes a more systemic view, moving away from a linear evolutionary view and looking at how firms become embedded in the innovative environment in which they operate. According to this view, the hypothesized existence of related lifecycle phases should be criticized. The lifecycle model should therefore be replaced by different and distinct organisational categories. Each category then represents an adequate organizational approach for dealing with driving forces such as technology, environment, internal structure and leadership (Kazanjian and Drazin, 1989).

Limitation 2: Uncertainty and ambiguity as phenomena and contingencies in the models

The majority of life-cycle models do not take into account the impact of the high levels of uncertainty and ambiguity new ventures are confronted with. The model developed by Churchill and Lewis (1983), for example, states that in stage one - the 'existence stage' – expanding its customer base and delivering the required product or service are the two main challenges, but gives no insight into *how* a broader sales base can be established. According to Moore (1995 & 1999), a venture should target innovators and early adopters. However, the discovery of 'what' to offer to this type of customers and in 'which' markets is at best implicitly assumed within his framework. Also the model by Hanks et al. (1993) suffers from high degrees of implicitness on this particular subject. The Abernathy-Utterback model

(1975 & 1978), unlike most other lifecycle models, *does* take into account the uncertainty a company is confronted with when developing new market applications, and will be referred to further in this paper.

## III. What can be observed?

Based on the previous considerations and reflections, we need to explore and to study whether 'distinct' episodes by which NTVs reach a sustainable market application and subsequent position exist and can be discerned. Case study research is often advocated as most adequate for developing insights in real-time processes (see for example: Yin, 1985; Janesick, 1994; Eisenhardt, 1989). We studied and analyzed four NTVS. Two NTVs were initiated and exploited by independent individuals (start-ups according to the typology of Shane and Eckhardt) and two NTVs spun-off from academia (see Table 1 for an overview of their salient characteristics and data collection methods).

INSERT TABLE 1 ABOUT HERE

We first constructed a history of each company (see Appendices 1a through 1d). This resulted in a detailed event analysis (see Figures 1-to-4) suggesting the episodic evolution each company experienced during its history. The event time-line is illustrative of the major search and market application configurations occurring at each company.

As can be seen in Figures 1-to-4, the episodes can be characterized by organizing principles such as 'certainty/uncertainty,' 'stability of venture assumptions and goals,' 'clarity/non-clarity,' 'awareness/unawareness about or identification of critical issues,' 'materialization of critical issues.' Concepts occurring in the search for market applications are 'brainstorming,' 'experimenting,' 'prototypes,' 'pilot projects,' 'learning,' 'exploring additional options,' 'planning between alternative options,' 'deciding/focusing on and planning for one specific option,' 'changing approach according to materialization of critical events.'

When listing these concepts, a striking similarity with the new product development literature emerges. The NPD literature indeed often identifies events based on their degree of uncertainty and ambiguity and suggests processes for dealing with them, introducing concepts such as 'intelligent experimentation,' 'learning by doing,' 'planning,' etc.

INSERT FIGURES 1 TO 4 ABOUT HERE

## IV. Insights from the NPD literature

### *IV.1. Analyzing episodes of uncertainty and ambiguity*

Knowledge-intensive ventures are confronted with uncertainty, with regard to their technical options as well as to the market environment surrounding them. Likewise, project teams developing novel products are confronted with different levels and types of uncertainty. The degree of uncertainty and/or ambiguity does not only depend on the type of innovation or the level of complexity of the technology involved. It is not exogenous, but it is also determined by the context, the perspectives, the background and the experience of the actors involved (Pelz and Andrews, 1966).

In the literature on new product development, we find various classifications of different types of uncertainty. Sometimes, uncertainties are classified by their source (technicalities, market issues, quality issues, etc) or by their potential impact (see for example: Chapman, 1990). Other classifications relate uncertainty to the different management techniques required dealing with them. One of those typologies, suggested and developed by De Meyer et al. (2002), is highly useful to increase our understanding of the entrepreneurial development process and is therefore briefly discussed in Table 2.

INSERT TABLE 2 ABOUT HERE

Some authors (see for example Schrader et al., 1993) tend to label both 'variation' and 'foreseen uncertainty' as 'uncertainty.' 'Uncertainty' is thereby defined as a situation in which the relevant decision variables are known, but the organization does not know the exact values these variables should take. There thus is a difference between the amount of information available and the amount of information required to execute a task at hand (Galbraith, 1977). There hence exists an information asymmetry. What De Meyer et al. (2002) label as 'unforeseen uncertainty' and 'chaos' corresponds to what is often called 'ambiguity' (see for example Schrader et al., 1993): under ambiguity, there is lack of clarity regarding the relationships between the variables and the problem solving algorithm and sometimes

even about the set of relevant decision variables itself. Differing interpretations of the situation exist. It is unclear to the actors involved which information is needed to solve these differences (Van Looy, Debackere & Bouwen, 2001).

### *IV.2. Organizational Approaches*

Given the characteristics listed in Table 2, the adequacy of various organizational approaches will differ depending on the presence and the balance of the degrees of uncertainty versus ambiguity. In situations dominated by uncertainty, 'traditional' project management is appropriate (Debackere and Van Looy, 2003). The success of the NPD project depends on the speed and the resources with which all project phases are completed. Extensive use of clear goals and planning - using milestones and phases - can reduce uncertainty in the decision-making process and should reduce lead-times (see for example: Eisenhardt and Tabrizi, 1995).

In situations marked by high levels of ambiguity, characterized by different interpretations on the nature and the scope of the application envisaged, the 'traditional' approach of planning and intensive preparation of the product definition is not longer sustainable. Flexibility and adaptability (Iansiti, 1995; Verganti et al., 1998) allowing for the continuous inclusion of new information on market and technological developments until late in the development process (i.e. the pursuit of a 'window of opportunity' as suggested by MacCormack, 1998), gathering and incorporating sufficient knowledge before committing to one specific product concept, delaying the final concept choice, and experimenting (i.e. solving problems through iterative, though intelligently pursued, trial and error) then become the dominant organizational themes (Eisenhardt and Tabrizi, 1995; Thomke et al., 1996; Verganti et al., 1998).

The different organizational strategies that might be deployed as a function of the type of uncertainty encountered during the project, have been further elaborated by Pich et al. (2002). They discern between (1) instructionist, (2) learning and (3) selectionist approaches to project management and organization, with the relevance of each approach depending on the (in)adequacy of the information available (see Table 3). As suggested by Pich et al. (2002), the three project management approaches of instructionism, learning and selectionism – of which a short

overview is given in Table 3 - may represent different phases in a stage gate process, in which uncertainty is gradually reduced over the course of an NPD project.

INSERT TABLE 3 ABOUT HERE

## V. A propositional model to understand the episodical nature of NTV survival and growth

Based on insights from NPD literature and on findings from our four case studies, we propose that an NTV can experience different episodes of chaos, unforeseen uncertainty, foreseen uncertainty, and variation in order to transform an initial technological opportunity into a sustainable market application. These episodes need not to occur in a sequential and monotonic order. This suggestion is in line with Vesper's work (1990) that has shown that the five key ingredients of the process of organization creation (*technical know-how, the product or service idea, personal contacts, physical resources, customer orders*) need not to be combined in a linear, monotonic sequence, but rather, that they can be combined in a variety of different sequences. The four episodes that we derive from the NPD literature are also similar to the different degrees of stabilization or 'closure' as suggested by Bijker (1987 & 1995). The result of closure is that one artifact - that is, one interpretation as a synthesis of the negotiation process between the social groups involved - becomes dominant across all relevant social groups. This process of working towards 'closure' also reminds us of the pre-dominant design phase described by Utterback (1994) and Dosi (1982).

### *V.1. Chaos: exploring options through experimenting and learning*

In the **pre-business plan** phase of an NTV, the **basic structure** of the business plan and the business strategy may still be **ambiguous**. As the business unfolds, it will become clear that the 'future' venture may end up with a position completely different from its original intent (see also Mintzberg and Quinn, 1991, on unintended outcomes). During these formative phases, business strategy has to be considered emerging and will be based on learning and adjusting the balance of market, product and organizational activity (Wyer and Smallbone, 1999). The founders of **Image** and **L-goritm** went through episodes of 'chaos' before starting the company. These episodes occurred during the years they stayed within the university labs. They came up with interesting research results, but did not yet have a business plan or strategy in mind. One of the founders of L-goritm worked on a project of the university. They

developed algorithms that enabled the reverse engineering of 'real' objects through laser measurements and to re-construct these objects in a 3D CAD environment, enabling to rework and to further optimize them. Although the main applications at that time were intended towards the automotive industry, this industry did not become L-goritm's target market later on. The image processing technology of Image also found its origins at the university labs. In this case, no particular application or market segment was targeted during the academic research project.

An NTV may not only encounter episodes of 'chaos' at the moment of founding, though. Also later in its life, it may find itself – on purpose or by force – in a situation characterized by 'chaos.' **OOPs**, medio 1998 and six months after start-up, deliberately abandons the original business plan and strategy by introducing ideas about products for the development of applications for selling through the Internet. **@music**, in the fall of 2000 - almost two years after founding - and then under serious financial pressure, realizes that the one option chosen will not prove sustainable, at least not in the short run. @music starts to question its original B-to-C concept and is forced into an episode of **'chaos'**. The basic structures of the business plan and the strategy have now become ambiguous again. At the time the authors were interviewing the former shareholders and employees of @music – that is, in the summer of 2002 and thus one year after bankruptcy – the interviewees were providing them with different and sometimes contradictory and conflicting versions of what happened between fall 2000 and summer 2001. They also differed remarkably in their opinion of what went wrong or what should have been the right strategy during that episode. This divergence with respect to views and opinions, even one year after the official bankruptcy, may in itself be considered an indicator of the chaos characterizing this episode.

During a chaotic episode, it is important for an NTV to generate and to **explore** a variety of market application options given the resource and the knowledge base accessible and available to the NTV. This leads to the suggestion of the following 'script.' The best way to substantiate this exploration episode is through a combination of **experimenting with and learning from** fundamentally different approaches to market and product (see also: Wyer and Smallbone, 1999, on incremental learning through experimentation and trial and error; Stevenson et al., 1989 on a quick-to-market approach based on trial and error; Nicholls-Nixon et. al., 2000, on strategic experimentation; and Chesbrough,

2003 on experimentation with regard to business models). Through **iteration**, with multiple tests conducted in series or in parallel, the outcomes of different tests can be observed and compared. **Learning** allows for transferring new insights from one experiment to another. In practice, different options are generated through contacts with technology enthusiasts and early adopters (see also Moore, 1995 & 1999). In some cases **experimentation** implies that an idea is conceptually elaborated through these contacts and/or that a '**quick and dirty**' insight in the possible market application is developed. In other instances, **prototypes** are launched (see also Kazanjian and Drazin, 1989 & 1990).

In the 'chaos' period before start-up, the founders of **Image** explored different options by doing research on image processing and by developing a number of practical applications at the image processing lab of the university. Also in the case of **L-goritm**, different options were explored when doing research at the university labs. **OOPs**, during the chaos period from mid 1998 until mid 1999, explores an additional option through a 'proof of concept' research project, partially funded by a public R&D funding agency.

Through this **trial and error** process, the NTV explores as many options as possible, often generating additional chaos. However, once a broad range of options has been screened, enough information and insight may have been gathered so that promising trials can be distinguished from unpromising trials, leading the venture into a different episode characterized by reduced levels of ambiguity.

***V.2. Unforeseen uncertainty: studying options through experimenting and systematic learning***

The information gathered during an episode of iterative experimentation enables the founders of the NTV to define **reasonably stable assumptions and goals** with regard to the selection of 'promising' options. Based on these assumptions, the NTV team will try to forward its technology platform into the market options that are selected. However, there still remain **critical events of which the company is not aware**. Because of this unforeseen uncertainty, the start-up is not able to develop contingency plans. At the start-up of **L-goritm** in 1995, assumptions and goals are reasonably stable. L-goritm wants to become a product company, delivering software for reverse engineering to a variety of industry sectors. However, it is not clear whether this activity will immediately generate

revenues, indicating that not all the critical events have been identified. At the start-up of **Image** in 1982, the company's reasonably stable mission is the development of a general-purpose machine vision system. However, not all the critical events have been identified. The machine vision market is said to be in an embryonic stage of its lifecycle. Only rough and partial estimates and projections on the total market are available. There are no reliable data on the different market segments. For the founders of **@music,** the period from September until December 1998 can be considered an episode of 'unforeseen uncertainty.' While the initial concept slightly evolves from developing an MP3 site for unsigned artists to becoming an Internet platform for independent quality labels, assumptions and goals remain reasonably stable over this period. **OOPs's** founders, before starting the company in 1998, have jointly developed reasonably stable assumptions and goals regarding customized system integration based on their knowledge of object oriented programming. However, also they are not aware of all the critical events. Again we are thus confronted with a situation that can be labeled as 'unforeseen uncertainty.' During the period from mid 1999 until the beginning of 2001, **OOPs** is again operating under 'unforeseen uncertainty' regarding possible products for the development of applications for selling through the Internet. Although the outcome of OOPs's 'proof of concept' research project is promising enough to be further pursued, a lot of critical events still need to be identified. It is only in the beginning of 2001 that the company founders start realizing this when studying their sales results in depth.

Existing literature suggests that during an episode of 'unforeseen uncertainty,' the NTV might operate according to the following script. The NTV should **study** the selected options in more detail by taking a **flexible and adaptive approach**, without committing too many resources. We refer to the work of Florida and Kenney (1990) and Tegarden et al. (1999) on the irreversibility of early design choices, as well as to the work of Bhidé (1992 & 1996), Muzyka and de Koning (1996), Brown and Eisenhardt (1997) and Nicholls-Nixon et al. (2000) on the prominent role of flexibility and experimentation. **Experimenting** with these options and **systematic learning** from the experiments conducted is crucial to make informed choices. Learning is 'systematic' if new experiments are set up in a way that they build on insights from earlier experiments. We should thus identify 'unforeseen' events and conduct a new round of selection of options and subsequent planning on the basis of this identification. Systematic learning, though, is only possible between serial experiments (see also Thomke et al., 1998 & 2003). Under 'unforeseen uncertainty,' experimenting will

most often take place via **pilot projects** with early adopters (see also Moore, 1995 & 1999) or via the launch of inexpensive **experimental products** (Tegarden et al., 1999). During the period from 1995 until 1997, **L-goritm** is selling services and developing software for reverse engineering as well as for quality control. It is thus studying three different options. During these early years, much is learned about technical aspects, market applications and sales. As for distribution, L-goritm is also experimenting with various approaches. At the end of 1997, an indirect dealer network is set up. This allows L-goritm to learn about the privileged position of hardware producers and about the inappropriateness of indirect sales for generating reference accounts. **Image** experiments and learns about unknown critical events through responses to the educational texts it distributes and through different projects for end-users across different industries. In each project, the product is adapted to the customer and the technical feasibility as well as the potential sales are screened.

The three founders of **@music**, during the 'unforeseen uncertainty' episode from September until December 1998, start from an initial idea (developing an MP3 site for unsigned artists) and study related options through extensive discussions and brainstorm sessions. The founders search for information on technologies and markets. Information and forecasts from industry reports allow them to learn about critical issues and lead to the final concept choice. The founders of **OOPs** initially study the option of offering customized system integration based on knowledge of object oriented programming by doing a number of projects for financial institutions. Working on those projects allows them to experiment and to learn about unknown issues, such as customer needs with regard to system integration, limitations and opportunities of object oriented programming, and business opportunities for matching this technique with customer needs. From mid 1999 until mid 2000, **OOPs** studies two options in test projects. As for customized system integration, the company does a number of consulting projects in the financial sector. As for sales support over the Internet, OOPs starts to develop a product - named 'Spoot' - consisting of different functional modules. At the same time, marketing and sales are developed. The company invests in product folders and product packaging. The company experiments with sales through partnering as well as with direct sales. However, during this period, no systematic learning takes place. It is only in the beginning of 2001 that the company founders start to identify and to systematically learn about critical events by accompanying the sales people during sales visits. Listening to the needs

of the customer, finding the right contact person within the customer companies, and defining the right target group are found to be critical issues. At the technical level, the fundamental non-solvability of the 20/80 problem becomes clear.

**Multiple options/approaches** always need to be kept in life: if unforeseen events are identified that could jeopardize the success of a certain market application, alternatives need to be available for further study. On the other hand, if for some options the majority of unforeseen events have been identified and proven favorable, they then have become **foreseeable, and the options will be taken into further consideration.** In this way, unforeseen uncertainty can lead to foreseen uncertainty.

***V.3. Foreseen uncertainty: planning between and across options***

Under 'foreseen uncertainty,' **critical events** that influence the sustainability of the NTV's options have been identified, but one **cannot be sure when, or even whether or not, they will occur**. Mid 2001, **OOPs** has been able to identify critical events such as the need to listen to the needs of the customer, finding the right contact person within the customer companies, defining the right target group and the fundamental non-solvability of the 20/80 problem. These conclusions bring OOPs into a phase of 'foreseen uncertainty.' **Image**, by the beginning of 1984, has screened all its pilot projects on technical feasibility and potential sales. It is now able to retain two projects and their respective critical issues, which result in the development of two products. Critical events have already been identified, such as the fragmentation of the market, the variety in possible product offerings and differences in customer requirements. However, the exact market value of the different segments is not yet completely clear, and the actual requirements of the bulk of the market versus those of the early adopters are not known. Between 1989 and 1991, **Image** again finds itself in a phase of 'foreseen uncertainty' in order to define new business opportunities in additional niches. Critical issues are: (1) the fact that it is not clear whether an integrated or stand-alone machine version will dominate the market, (2) the fact that market size and dominant technology are not known, (3) the substitution threat (meaning that improvements in semiconductor packaging techniques would eliminate the need for inspection), and (4) the possible subcontracting risks. **L-goritm**, by 1998, has learned about the privileged position of

hardware producers, about the importance of the geographical scope and about the inappropriateness of indirect sales for generating reference accounts. By 1998, L-goritm has thus identified critical events with respect to its activities and comes into a phase of 'foreseen uncertainty.' By 2002, **L-goritm** has become aware of additional opportunities and the corresponding critical events. The company therefore partly returns to a situation of 'foreseen uncertainty' with regard to two additional market options: the development of quality control products for standard robots and for CMMs. A similar partial fallback to 'foreseen uncertainty' occurs in 2003, when **L-goritm** decides to develop specific modules for additional niches (turbines and mobile phones). At **@music**'s start-up in the beginning of 1999, critical issues have been identified such as the lack of standards for the exchange of music through the Internet, the importance of Internet diffusion and Internet users' buying behavior for the company's success. Although one cannot be sure of how these critical issues will evolve (suggesting an episode of 'foreseen uncertainty'), industry experts and firms in the music industry are at that time confident in the survival of the new industry paradigm of selling music over the Internet (as illustrated also by the success of @music at the Midem fair 2000). Only in the fall of 2000 it becomes clear that some critical issues are negative for the viability of the @music concept. Especially the general Internet users' buying behavior, reflected in the fact that visitors of @music's website come to listen rather then to buy, poses a major problem.

In a situation of 'foreseen uncertainty,' the following script can be suggested. **Risk management** becomes crucial. **Scenarios** and **contingency plans** are developed. If a critical event occurs, the company reacts by adapting to some extent a certain market application or by abandoning it altogether in favor of one of the alternative options. At the end of the decision tree, all critical events have materialized. This need for **planning between and across different options**, in contrast with an experimental approach under more ambiguous circumstances, relates to the findings of Stevenson et al. (1989) and Bhidé (1992, 1996 & 2000). **L-goritm**, in 1998, is planning between options, since it focuses on developing products for quality control, but at the same time is still offering services in the reverse engineering field. It is active in a variety of sectors. With respect to distribution, it is using local sales offices and OEM sales channels at the same time. Also in 2002 and 2003, **L-goritm** is planning between a number of additional options. In 2002, inspection products for CMMs as well as for standard robots are under consideration. In the spring

of 2003, the company is planning the development of specific modules for a number of segments, including mobile phones and turbines.

**Image**, from 1984 until 1988, is taking a stepwise approach to planning between and across options. The two projects that were selected at the beginning of 1984 represent the starting point of a decision tree that will gradually develop over the period between 1984 and 1986. Starting from its two initial products, Image plans (for the years 1984-1985) to focus on three promising market segments: the electrical/electronic/semiconductor industry, the automotive industry and the pharmaceutical industry. In the long run - that is as from 1987 - Image plans to narrow down its perspective even further. The selection of these target markets will be based upon technical considerations and upon market factors, which have not materialized yet. It is only in October 1985 that a first core market is identified: the alignment and the inspection on semiconductor and electronics assembly equipment. This selection is based upon technical knowledge of the sector and on newly available market data, representing a decision node in the decision tree. In 1986, a second possible target segment is identified, namely second-order optical inspection in the semiconductor industry. Critical events, such as the results of the market trial and the existence of synergies, turned out to be negative, and the option is dropped between September 1986 and October 1987. Between 1989 and 1991, **Image** is defining additional opportunities under yet another episode of 'foreseen uncertainty.' The development of its market offering is a clear example of planning between options. Until there is more certainty about customer preferences, both the stand-alone versions as well as the system for integration are developed. The same machine set-up is also sold in alternative way, namely to OEMs. **OOPs**, in 2001, is also able to work through a number of decision nodes by listening to customers and by monitoring customer needs. At the technical level, it is decided to work with technical modules instead of functional modules. Instead of selling a standard product - that is inevitably characterized by the 20/80 problem - it is decided to sell 'solutions.' Instead of talking about the Internet, OOPs starts to use the concept of B-to-B commerce. Heads of IT-departments are replaced by general management and commercial departments as the main 'target' persons. A profile of the target customer group is developed (national companies with an IT-department and a minimum turnover of 1 billion BEF). We further note that, both in the case of

**Image** as in the case of **OOPs**, no a priori contingency plans were developed. Both ventures gradually develop their final plan by working through the many decision nodes.

At the end of the decision tree, all critical events have materialized. If all options prove unviable, the venture will again be facing increased levels of uncertainty and ambiguity. In the other case, the venture may be able to **narrow down** its total range of options to (mostly 1 or 2) market applications, for which all critical events have materialized, thus bringing the venture into a phase of variation. For example, during 2002, **L-goritm** is developing quality control for standard robots and for CMMs. After a while, it is decided that the latter option will be pursued, while the former will be postponed and reconsidered later.

***V.4. Variation: planning within options***

Market applications for which all the critical events have been understood and materialized can now be further developed. The **NTV's objectives and the general configuration** of these market applications are clearly **defined**. Market elasticity is also known. **Variation arises through small changes** in technology, product or market features, such as market differentiation, variations in packaging or incremental changes to the technology base. The following script unfolds.

In order to manage this variation efficiently, detailed and stable **planning** at the budgetary level is now required. Since market elasticities are known, **simulation** at the product/market level can be used and is used for **modeling** the effects of variations in margins and functionalities on budgets, market size, market penetration and turnover.

In the case of **L-goritm**, a number of critical events materialize during the period 1999-2001, bringing L-goritm into an episode of 'variation.' The acquisition of MicroM GmbH leads to a complete offering, including software and hardware. Quality control is preferred over reverse engineering. Both service and product activities are retained. The company has opted for direct sales instead of through OEMs, for higher prices and for a reduction in geographical diversification. Mid 2001, the automotive sector is chosen as the main target segment. We might say that L-goritm is

at that moment planning within an option - or even better - planning within two options: quality control services and quality control products offered through direct sales to the automotive sector. By 2003, **L-goritm's** CMM option is taken into a phase of 'variation' and for this niche, a different distribution approach is adopted, namely indirect sales through CMM producers. By the spring of 2003, L-goritm is thus planning within a number of options. Reverse engineering is seen as a side activity. The main focus is on quality control and on the automotive sector. The standard product that is sold to the automotive sector can also be used in and is hence also sold for other applications, e.g. in the aerospace and consumer goods sector. **Image**, by working continuously on the alignment and the inspection of semiconductor and electronics assembly equipment, is able to identify all relevant technical and market factors and to bring itself into a phase of **variation** by 1988. It is in the same gradual way that **OOPs**, in 2003, reaches its first successes – and a situation of variation - in the construction sector.

INSERT TABLE 4 ABOUT HERE

***V.5. Episodes, scripts and their implications: match versus mismatch?***

From the above analysis, it appears that the various levels of uncertainty and ambiguity have their specific implications on developing market insight and application selection (see Table 4 for a summary). When analyzing the case of Image within the framework of the episodical model developed, we gain an insight into the possible 'match' between each of the different episodes and the concomitant scripts deployed to select sustainable market application(s) as suggested in Table 4. Based on the cases of @music and OOPs, though, we find that the match between episode characteristics and organizational scripts may sometimes become much more blurred.

At **@music**'s start-up in the beginning of 1999, critical issues have been identified such as the lack of standards for the exchange of music through the Internet, the importance of Internet diffusion and Internet users' buying behavior for the company's success. One cannot be sure of how these critical issues will turn out, and under this kind of 'foreseen uncertainty,' the model summarized in Table 4 would suggest to plan between different options. However, @music – consistent with the agreement of industry experts and players in the music industry on the future dominance of this new industry paradigm – decides to choose a single concept for further pursuit: the NTV should

become an Internet platform for independent quality labels and should generate revenues as a percentage of the on-line sales of these labels through this platform. No contingency plans are developed in case the identified critical issues would turn out negative. Only by fall 2000 - after two years of planning within an option - it becomes fully recognized that visitors' buying behavior is not as expected and that the pursued option is therefore not viable in the short term.

**OOPs**, in the summer of 2000, is experiencing an episode of 'unforeseen uncertainty': the fundamental 20/80 problem has not yet been recognized and the sales approach and the definition of the customer target group have not been identified as critical yet. Nevertheless, the company decides to focus solely on 'Spoot' sales and to abandon the initial consulting activity of customized system integration, thus implicitly taking a 'planning within an option' approach. However, at the beginning of 2001, OOPs realizes that no progress in sales is made and that a lot of critical events still need to be identified. The company then goes back to 'studying options.' This then allows OOPs to identify critical issues such as the 20/80 problem, the need to listen to the customer, the need to find the right contact person within customer companies, and the need to define the right target group.

We therefore propose that a 'match' between episodes and market selection scripts as suggested in Table 4 should preferably exist, since it allows the NTV to identify and to collect the specific information and knowledge needed for its survival. In the absence of this match, the NTV will be confronted with many unrecognized blind spots, and hence may lose sight of vital knowledge that has to be generated in order for the NTV to select a sustainable market application. Note however that, as the venture grows, various scripts may be pursued and may co-exist in parallel. This is what happens in large, incumbent firms that have adopted innovation portfolio approaches.

### ***V.6. Non-linearities and iterations between episodes: adaptability, uncertainty reduction and generation***

A logical sequence appears at first to emerge from the model proposed in Table 4, suggesting almost sequential transitions between the different episodes. A sequence from 'chaos' to 'variation' indeed would appeal to a rational-positive logic (see Table 4). This would correspond to the 'traditional' view that successful entrepreneurs commit in

stages as a response to new competitors, markets and technologies (Stevenson and Gumpert, 1985) and that uncertainty is reduced accordingly in a step-by-step manner (Abernathy and Utterback, 1975 & 1978). However, based on the case event-timelines, we need to stress that not every NTV follows this 'picking order.' Because of the daunting and unavoidable presence and impact of uncertainty and ambiguity, episodes may be skipped and fallback positions may prove necessary. The origin of the venture can play a major role in 'jumping' episodes. For example, differences can arise between independent start-ups and NTVs that spin-out of existing organizations, since the later can use the resources, the relationships and the reputation provided by the existing organization to develop a relatively clear view on potential market applications. (cfr. Bhidé, 2000).

On the other hand, feedback loops may also prove to be necessary. This corresponds to Bijker's proposition that the process of closure can be a highly erratic one (Bijker, 1995). A common phenomenon is that NTVs often think they have the winning lottery ticket, that all relevant stakeholders (such as investors and potential customers) agree on the meaning and the usefulness of their market application, which leads them to the incorrectly belief that they are in the more comfortable situation of foreseen uncertainty. If they realize relatively soon that their selected market application is not as viable as they thought, they can still fall back to exploring or studying additional options (see the OOPs case). However, if too many resources are consumed before this insight is reached, investors and other stakeholders may not be willing to support a new episode (marked by increased levels of uncertainty and even ambiguity) and the venture may hence fail (see the @music case).

In addition, the NTV can deliberately return to an episode with a higher level of uncertainty and ambiguity in order to broaden its range of options. OOPs, right after founding, returns to 'chaos' in order to explore an additional option. Image, in 1989, starts a program for defining business opportunities in additional niches and in this way returns part of its attention to foreseen uncertainty (following a 'portfolio' approach). The same deliberate and partial shift takes place at L-goritm twice, when defining additional options in 2002 and in the spring of 2003. In these three cases, the script for selecting market applications changed accordingly.

The consequence of those observations, as they are linked to the model proposed in Table 4, is that the NTV should be able to adapt its scripts during its search for a sustainable market application. We call this ability to move efficiently and effectively between episodes and their related scripts the adaptability of a venture. We propose that adaptability is the dynamic capability of a venture to cope with episodical transitions. Where the concept of dynamic capabilities is traditionally linked to integrating, building, and reconfiguring internal and external competencies and resources to address changes in the firm's environment and market conditions (Teece et al;, 1997; Helfat and Raubitschek, 2000, Eisenhardt and Martin, 2000; Helfat & Peteraf, 2003), adaptability relates to the development of competencies and resources to address varying degrees of uncertainty/ambiguity regarding the firm's environment and market conditions.

## VII. Episodes, scripts, adaptability: concluding reflections and suggestions for further research

Because of the uncertainty and the ambiguity about their technology's applications and the market opportunities facing them, technology-based ventures experience multiple challenges when developing their initial technology into actual market applications. It further appears that the choices involved should not be considered as decisions that are taken at discrete points in time, but rather as an ongoing search, learning and decision-making process, consisting of different development episodes. We have suggested that coping with these different episodes essentially is a non-linear and iterative process.

Given this non-linearity and the high levels of uncertainty and ambiguity technology-based venture are confronted with, lifecycle models are considered less appropriate to understand the processes by which these companies develop their technology capability into a sustainable (array of) market application(s). An analysis of four case studies points to various similarities between this search and learning process in venture development on the one hand and similar processes in new product development contexts on the other hand. We therefore found it useful to better examine insights from the New Product Development (NPD) literature, where decision-making under uncertainty and ambiguity has since long been a dominant theme. Based on insights from the NPD literature and from our case study analyses, we proposed a model describing four episodes and accompanying scripts that characterize the NTV's

search for a sustainable market position. We stressed that these episodes should not be considered as a monotonic, sequential progression from one stage or phase to another one; episodes may be skipped and fallback positions may be necessary.

We further pointed to the fact that as venture grow into established companies, they may pursue multiple episodes in parallel. In other words, portfolio management allows the firm to experiment with uncertainty and ambiguity in some of its activities (characterized by episodes of chaos and unforeseen uncertainty). However, at the same time it enables the pursuit of step-by-step, incremental product and technology innovations that are linked to episodes of foreseen uncertainty and variation, as described in the model.

Episodes and scripts indeed occur in the life of any NTV. Still more important, though, is the capability of the NTV to move between the episodes. Given the uncertainty and the ambiguity that characterize the search for market application(s), the likelihood that NTVs will have to move between episodes is very high. This capability to move between episodes and matching scripts has been identified as the 'adaptability' of the NTV. The cases of @music and OOPs tend to indicate that the availability of financial resources could be of influence on the adaptability of a venture.

This exploratory research needs to be further pursued in order to empirically validate and test the episode-script model of NTV survival and growth developed with the present analysis. During this validation, additional factors that enable or constraint an NTV's adaptability need to be identified. Although the case studies presented here give an indication of the role of financial resources, we want to gain insight in how the interplay of multiple enablers and constraints influences the ability to move and switch along the four episodes and scripts identified.

**Tables and Figures:**

| Company | Origin | Activity | Performance | Data sources |
|---|---|---|---|---|
| @music | Independent Start-up | E-commerce | Failure | ▪ e-mail correspondence, meeting reports, financial reports;<br>▪ 11 interviews with investors, founders and employees. |
| OOPs | Independent Start-up | Software / Service / Product Provider | Survivor | ▪ interviews with two founders and one employee |
| Image | Academic Spin-off | Machine Vision Systems | Survivor | ▪ interview with the former CEO;<br>▪ analysis of all the business plans. |
| L-goritm | Academic Spin-off | Software / Service / Product Provider | Survivor | ▪ interview with founder/CEO;<br>▪ analysis of the business plans. |

**Table 1:** Case study overview

| | Type of Uncertainty | Characteristics of Management Processes |
|---|---|---|
| UNCERTAINTY | Variation | ▪ clearly defined objectives;<br>▪ sequence and nature of activities perfectly known;<br>▪ variation can arise from the combination of many small influences;<br>▪ variation can influence budgets and schedules. |
| | Foreseen Uncertainty | ▪ stable assumptions and goals;<br>▪ all possible influencing events on the development process and adequate courses of action are identified and understood;<br>▪ not sure whether or not these events will occur. |
| AMBIGUITY | Unforeseen Uncertainty | ▪ reasonably stable assumptions and goals;<br>▪ impossible to identify all possible influencing events and adequate courses of action. |
| | Chaos | ▪ continuous redefinition of assumptions and goals;<br>▪ basic outlines of the project plan are uncertain;<br>▪ final results can differ completely from original intent. |

**Table 2:** Mapping uncertainty and ambiguity (based on De Meyer et al., 2002)

| | | Management Approach | Process Characteristics |
|---|---|---|---|
| INFORMATION ADEQUACY | Low risk | Task Scheduling | ▪ variability (σ) of outcome is known<br>▪ detailed project plan<br>▪ built-in buffers<br>▪ modeling, simulation<br>▪ monitor variations and compare against plan |
| | High risk | Risk Management - Contingent Action | ▪ probability (P-values) of outcome is known<br>▪ decision-trees<br>▪ scenario-planning<br>▪ contingency plans<br>▪ monitor triggers |
| INFORMATION INADEQUACY | | Selectionism<br><br>*In combination with*<br><br>Learning | ▪ iteration<br>▪ trial and error<br>▪ experiments, tests in market<br>▪ pilot customers, pilot projects<br><br>▪ screen for unforeseen events<br>▪ respond, replan |

**Table 3:** Project management approaches in the face of uncertainty (based on Pich et al., 2002)

| Episodes in Market Application Selection | Scripts for Market Application Selection |
|---|---|
| Variation:<br>▪ Clearly defined objectives;<br>▪ Sequence and nature of activities known;<br>▪ Variation arises from differentiation and incremental changes to technology base. | Planning within an Option:<br>▪ Detailed and stable planning;<br>▪ Modeling, simulation. |
| Foreseen Uncertainty:<br>▪ Identifiable and understood influences of which the NTV cannot be sure they will occur. | Planning between and across Options:<br>▪ Risk management;<br>▪ Scenario-planning;<br>▪ Alternative contingency plans (policies; decision trees). |
| Unforeseen Uncertainty:<br>▪ Reasonable stable assumptions and goals;<br>▪ There exist critical events of which the NTV is unaware;<br>▪ Inability to create contingency plans. | Studying Options through Experimenting and Systematic Learning:<br>▪ Experimenting (try fundamentally different approaches, in series or in parallel);<br>▪ Systematic Learning (look for unknown critical events and replan). |
| Chaos:<br>▪ Pre-Business Plan;<br>▪ Basic structure of the business plan and strategy is unclear;<br>▪ Often ends up with results completely different form original intent. | Exploring Options through Experimenting and Learning:<br>▪ Trial and error;<br>▪ Iteration;<br>▪ Experiments (try fundamentally different approaches, in series or in parallel);<br>▪ Learning (look for unknown critical events and replan). |

**Table 4:** Process episodes and scripts

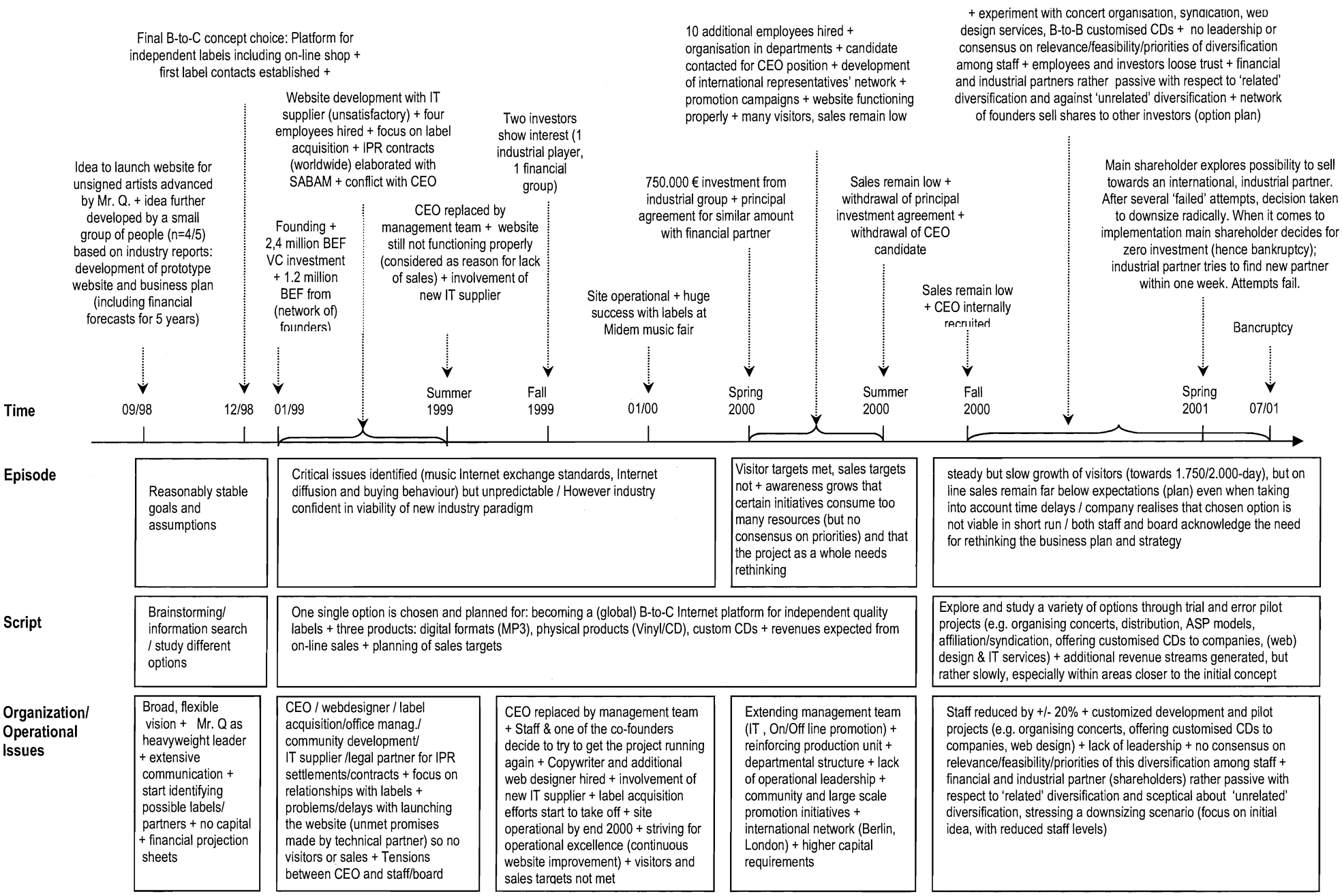


**Figure 1:** Event history of @music

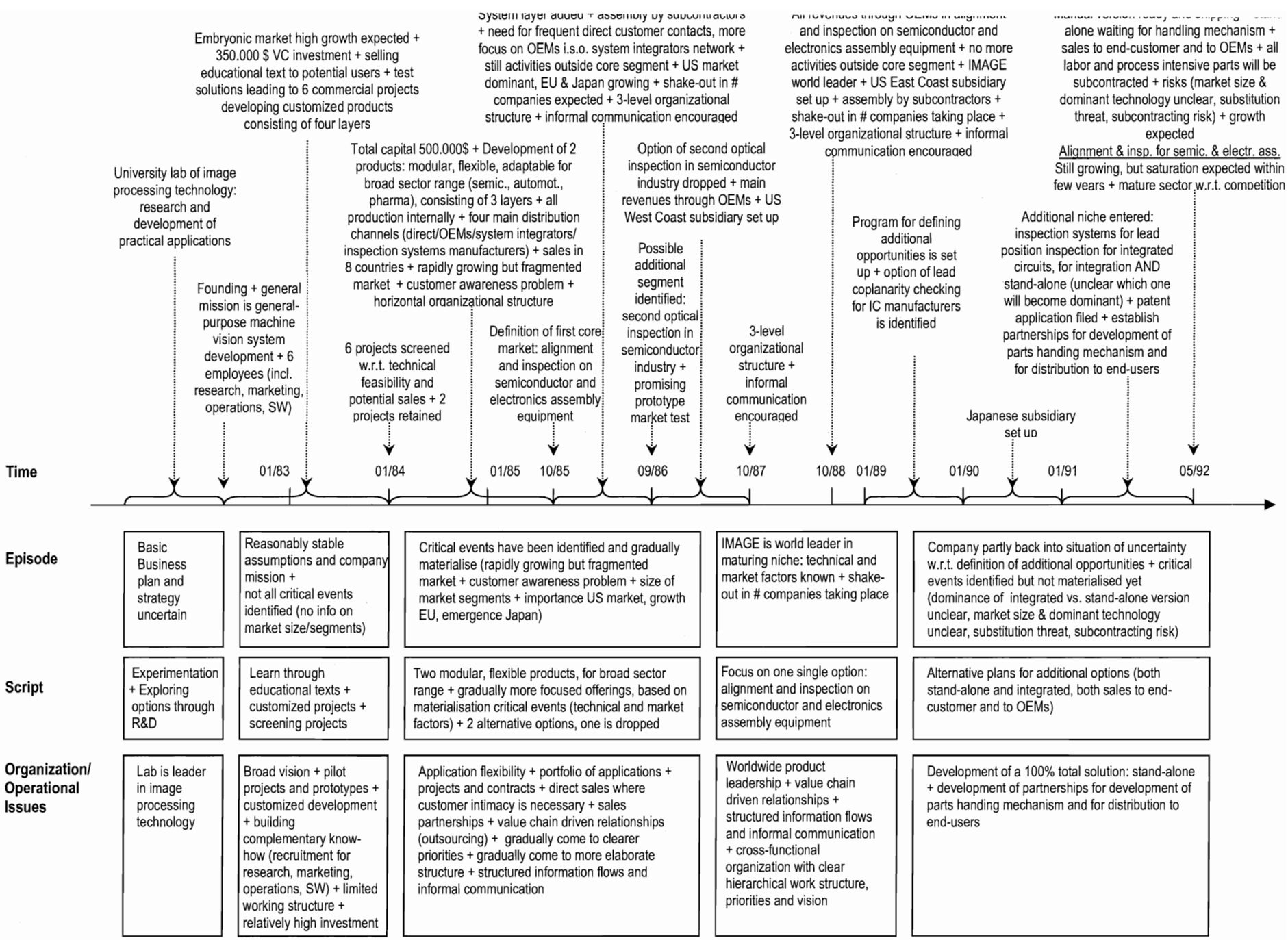


**Figure 2:** Event history of Image

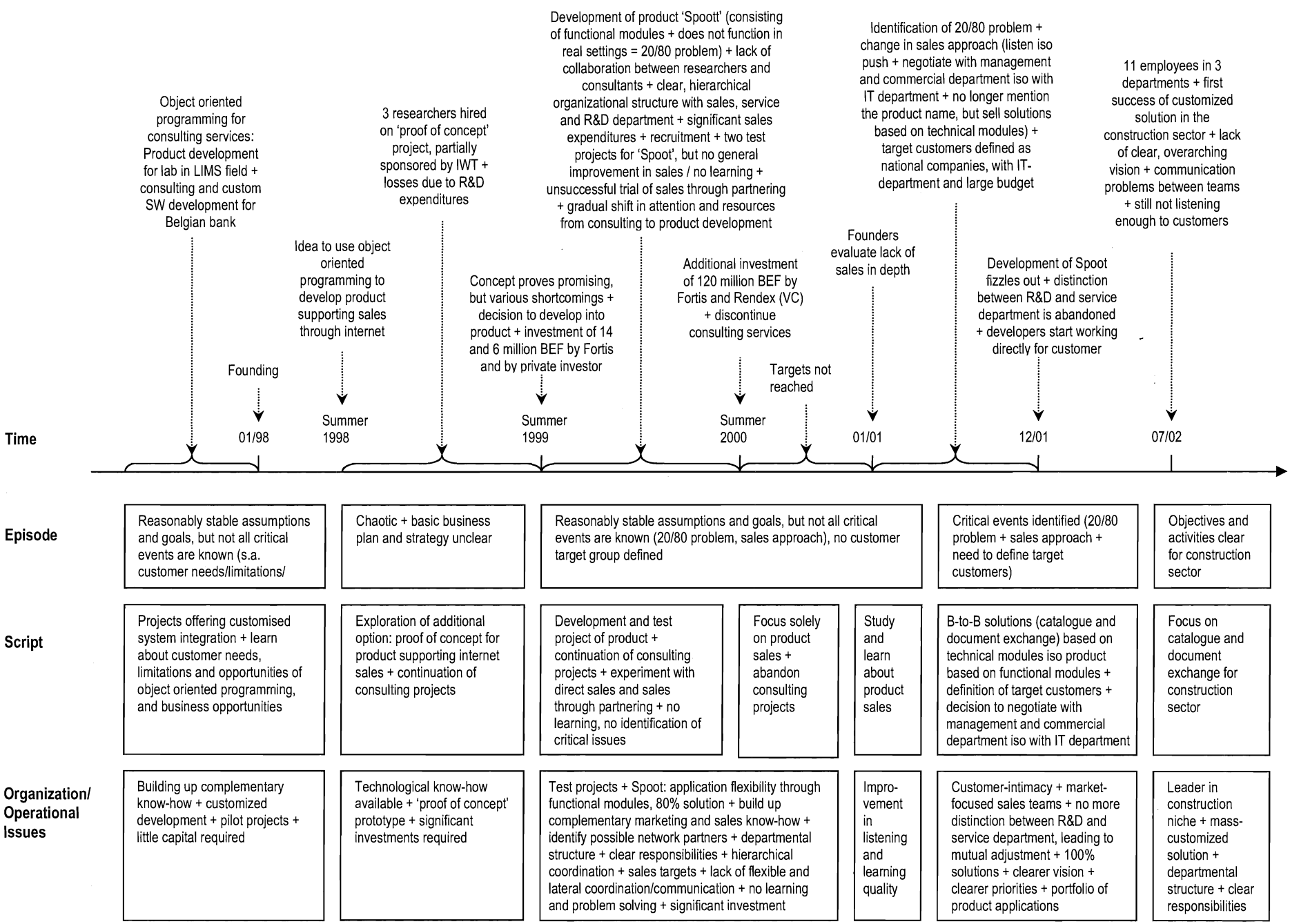


**Figure 3:** Event history of OOPs

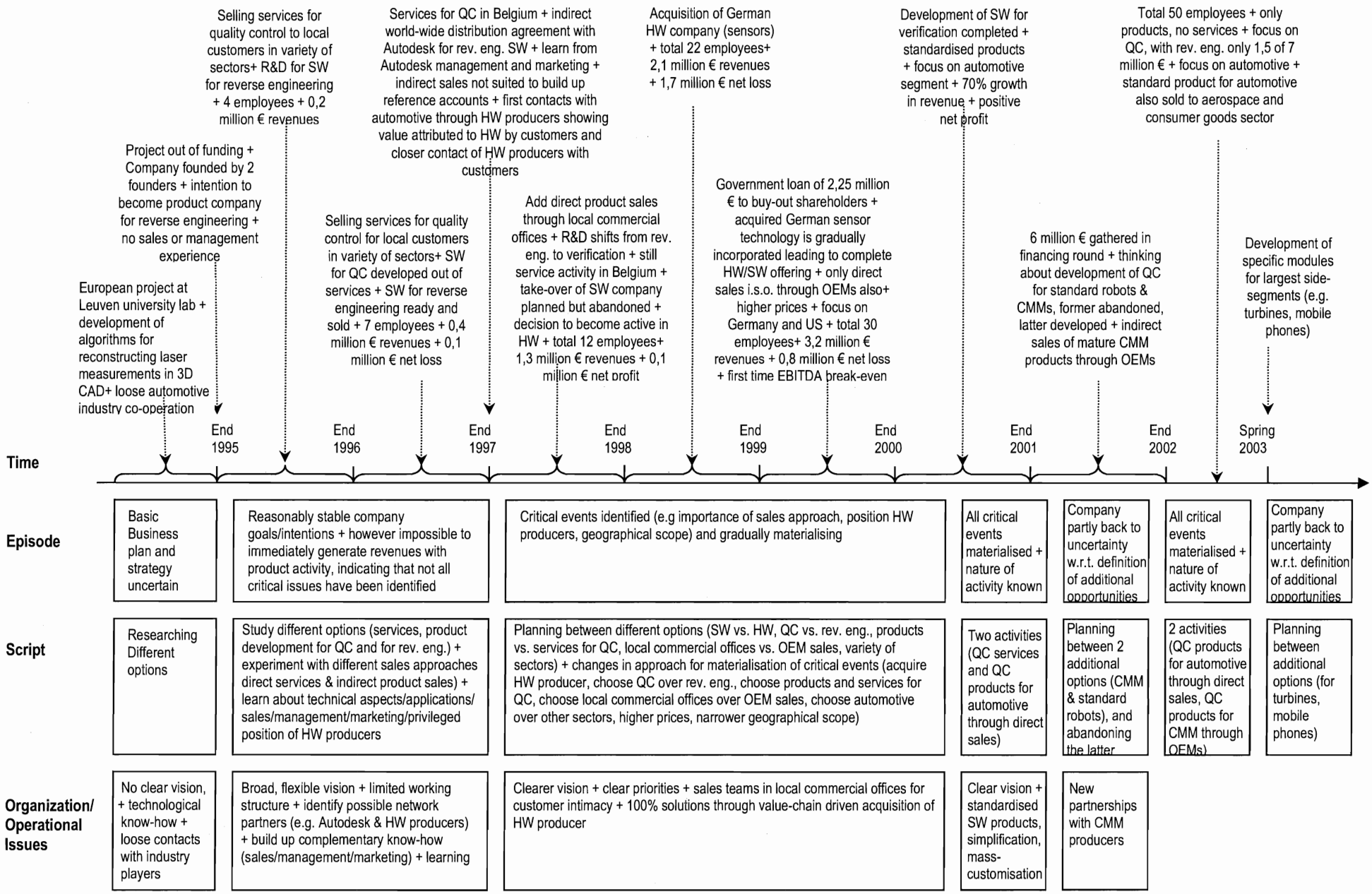


**Figure 4:** Event history of L-goritm

## Appendices

### Appendix 1a: History of @Music

In **September 1998**, three friends - Mr. Q., Mr. D., and Mr. V. - start brainstorming about setting up a company to sell alternative music through the Internet. The idea evolves from developing an MP3 site for unsigned artists to becoming an Internet platform for (independent) quality labels. In **December 1998**, a fourth acquaintance, Mr. M., is taken on board to initiate relationships with labels. The first financial projection sheets are written.
@music is officially founded in **January 1999**. The VC company Euritec (later named Arkos) agrees to invest approximately 2,4 million BEF. Mr. Q. is responsible for the practical organization and the website, and implicitly takes on the role of CEO. Mr. D. does the web design and Mr. M. is responsible for labels. Mr. V. does not take any formal position in the company, but will remain of influence during the next two and a half years.

**Between January and June 1999**, most effort is put into contacting labels in order to arouse their interest in partnering, and into the development of the technical infrastructure. Four employees are hired. Two major problems arise during this period. Firstly, the development of the website - in cooperation with a company called Evisor - is subject to numerous delays and serious technical shortcomings. Secondly, Mr. Q. is dissatisfied with the speed at which Mr. M. is signing labels. This conflict leads to an unpleasant working atmosphere. In the **summer of 1999**, Mr. Q. is paid to leave the company. Together with him, two of his friends leave the company. A management team is formed, consisting of the three remaining founders and one additional employee. A new website is released, for which Evisor partners with another company called Lesire. Unfortunately, this website does still not function properly. This is seen as the main reason for the lack of sales. A positive note is the agreement reached with Sabam regarding Internet sales. @music is the first Belgian company to establish this arrangement.

**From fall 1999**, things start to brighten up. Two companies - Fortis, a financial institution, and Concentra, a media holding looking to diversify - express their interest to invest in @music. Evisor is replaced fully by Lesire as @music's web design partner. A free-lance designer is taken on board. In **January 2000**, the stand of @music at the Midem in Cannes - the largest yearly music fair in Europe - is a huge success. Numerous partnerships with labels are signed. Encouraged by this success, Concentra invests 30 million BEF in **springtime 2000**, and Fortis enters a principal agreement of another 30 million BEF. This money is used to recruit about 10 more people, bringing the total number of employees at about 15. The existing management team is organized in departments (coordination, labels, communication, production, and IT). In addition, the fresh capital is used to develop a network of international 'representatives'. As suggested by the investors, the marketing department launches relatively large promotion campaigns. Mr. G., an acquaintance of Mr. V. is contacted in order to become CEO.

However, although the Lesire website goes on-line in spring 1999 and functions properly, sales remain low. Although the number of visitors on the website rises constantly, these visitors are only listening to the on-line tracks, but are rarely buying. In the **summer of 2000**, Fortis therefore unexpectedly decides to withdraw its principal agreement of investing 34 million BEF. This brings about a desperate need for cash, since @music's investment in additional personnel, internationalization, and promotion - as discussed above - has consumed 1 million euros of cash. Also, Mr. G. decides not to become CEO of @music.

In the **fall of 2000**, Mr. M. who has been responsible for labels, becomes CEO. He tries to reduce expenditures by firing a number of employees and letting some of the others work on a part-time basis. At one point in time, a more drastic reorganization with major cut-backs in personnel is suggested, but this is never put into execution. Following suggestions of Mr. V., @music starts to question the original B-to-C concept, and decides to try out new activities, related as well as relatively unrelated. A concert is organized, and websites are built for other companies. One tries to establish contracts for syndication - putting interviews and videos of artists that are selling through @music on other websites, for example of radio stations - and for B-to-B custom CDs - selling customized CDs to companies who then offer these CDs to customers or employees.

However, this diversification attempt does not become very successful. Unlike Mr. B., the rest of the board of directors - including the investors Arkos and Concentra - oppose to any activity unrelated to music, even though from January until May 2001, services to other companies (mainly web design) are responsible for almost five times the turnover accounted for by on-line sales. In addition, most of the remaining employees are not fully motivated to support this diversification attempt. On the one hand, the diversification approach as suggested by Mr. V. requires all employees to take on sales responsibility, something they are not all trained for. On the other hand, they are not convinced of the usefulness of diversification and they are confused by the lack of a coherent plan in this regard and by the fact that the CEO, Mr. M., never explicitly supports this approach.

In the **spring of 2001**, sales are still low, both for on-line sales as for other activities. There is no more money left and due to bad results and the first bankruptcies in the Internet sector, Arkos looses its thrust and starts looking for investors to take over its shares in the company.
In **June 2001**, it becomes clear that no new investors can be found. The initial founders put forward a plan to continue with minimal human and financial resources. However, investors do not agree, and in **July 2001**, @music officially goes bankrupt.

## Appendix 1b: History of OOPs

OOPs is founded in **January 1998** by Mr. E. and Mr. P. in the region of Leuven (Belgium). Both founders have jointly built up experience as service providers. More specifically, they have developed part of a product for a software provider in the 'laboratory information management systems' (LIMS) field and provided consulting and custom software development for a Belgian bank. Object oriented programming has been at the basis of their services. Initially, the newly founded company continues these activities, offering customized software based on object-oriented programming. These consulting projects are profitable and little capital is required.

**Medio 1998** the idea grows to use the technique of object oriented programming to develop a product that can support the development of applications for selling through the Internet. Funding is partly provided by the IWT, a governmental organization, to develop a 'proof of concept'. The company is now making losses due to investment in research. At the end of the research project, the concept proves promising, although the structure of the prototype and the different components show various shortcomings.

**Medio 1999**, the company decides to develop the concept into a product and looks for investors. Fourteen million BEF is invested by Fortis. A private investor/director brings in an additional six million BEF. With this injection of capital, a product named 'Spoot' is developed, consisting of different functional modules. Two major problems arise during this period. Firstly, the product does not appear to function in real settings. This can be referred to as the 20/80 problem. The product offers an 80% solution for the customer's problem. However, adapting the product to the environment to solve the other 20% is so difficult, that it would be more practical to develop a customized product starting from scratch. At the time, this problem is not yet recognized. Secondly, a lot of time and effort is wasted because of lack of collaboration between consultants and researchers. Although the initial idea was to develop the product on the basis of consulting experience, in reality this knowledge is not shared with the research team. At the same time, marketing and sales are developed (product folders and packaging). Experienced sales people are hired, bringing the total number of personnel at about 15. The idea is to sell the product through partnering. A test-project is launched, without success. Selling directly to IT-managers of company's does not work either. Competing with large, established players is difficult especially when selling an invisible product. Furthermore, selling to IT-managers is difficult, since they have the tendency to believe that they could develop the product themselves in a cheaper and better way. Even if IT-managers can be convinced, in the end they are still unsatisfied with the product due to the 20/80 problem mentioned above. These problems, however, are not clear at that time. Investors believe that sales can be improved by hiring an expensive, experienced sales manager, Mr. T., who is given 'carte blanche'. Mr. T. hires a sales team of about 20 people, and organizes the sales department in a hierarchical way. The company now has a clear structure, consisting of a sales, a service, and an R&D department, with a clear scission between R&D and services. Despite these structural changes and large expenditures, there is no improvement in sales. At this time, the company is still involved in consulting projects offering customized system integration based on object-oriented programming, but project activity is gradually reduced efforts are redirected towards product development.

**Medio 2000**, the twenty million BEF is used, and an additional 120 million BEF is invested by Fortis and Rendex, a VC company. A new business plan is written, estimating the company value at 600 million BEF. It is decided to discontinue the original consulting activities, and to focus solely on 'Spoot' sales, including international expansion. Technical improvements are made, but the fundamental 20/80 problem remains unsolvable and unrecognized, and sales efforts - both through partnering and directly to IT-managers - fail to reach targets.

In the **beginning of 2001**, the company founders start to evaluate sales results in depth. They conclude that the company's sales approach is wrong and recognize the 20/80 problem. It is decided that the company will listen to the problems and needs of the customer, and that negotiation will take place with the client's management and commercial department instead of with the IT-department. The reasoning behind this is that management and sales are aware of the 'real' problems, whereas IT is more concerned with technicalities. Although its development continues, the product 'Spoot' is no longer mentioned as such. Instead, the company will sell 'solutions', consisting of technical modules, based on existing capabilities and software. Whereas the focus used to be on selling through the Internet, the company is now into solutions for B-to-B commerce. Based on sales visits, the company founders define their target customers. These are national companies, with an IT-department and a minimum turnover of 1 billion BEF. No market segments are defined: industry sectors are targeted based on previous results. The sales manager Mr. T. and his whole sales team are fired. The former marketing team becomes responsible for sales. In **December 2001**, development of Spoot fizzles out. The distinction between R&D department and service department is abandoned, and all developers start working directly for the customer.

In **July 2002**, the company has 11 employees, working in 3 departments (sales, pre-sales, and development) and sales people are still accompanied by the company founders. Sales have grown, especially for catalogue and document exchange applications. In the construction sector, networking - i.e. selling to customers of customers of customers - has proven very successful, and for the first time in one year and a half, a name has been given to this solution, namely 'Matconnect'. However, this does not mean that it is a standardized solution. 'Matconnect' is customized to the needs of the client. Although sales are going well, the company still faces some problems. According to Mr. P., one of the founders, some of the sales people are still not listening enough to their customers. In addition, there exist communication problems between different teams, and there is lack of clear, overarching vision. The company is working on the latter problem, by organizing internal workshops on company vision and values.

## Appendix 1c: History of Image

Image is founded in **1982** as a spin-off of the University of Leuven by Mr. DV, an experienced executive and Mr. O, Professor and scientist at the University of Leuven in the field of image processing technology. His lab is one of the leaders in image processing research in Europe and has developed a number of practical applications. The company's general mission is the development of a general-purpose machine vision system.
Until 1983, the machine vision market is said to be in an embryonic life stage, but for the period 1984-1985 a compound market growth rate of 158% is expected. Based on these promising projections, the VC company Advent, one year after Image's founding, invests 350.000$.
Image at that time employs two researchers of Professor O.'s lab, one marketing manager, one operations manager, one SW manager, and one president with management experience.
In order to raise customer awareness, an educational text is sold to potential users. When customers are interested, Image shows them a test solution, and if satisfactory, a commercial project is developed. Customers are situated in all kinds of industries (pharmaceuticals, brewery, etc.). At the end of 1983 -beginning of 1984, six projects are running in different industries, each project headed by one engineer, and all aiming to develop a product for repetitive sales. In each project, the product is adapted to the customer and consists of four layers: product hardware, system software, algorithms, and application software. However, developing such a large number of projects is not viable due to limited capacity in personnel and resources.

Therefore, at the **end of 1983 -beginning of 1984**, all ongoing projects are screened with regard to technical feasibility and potential sales. Only two projects are retained and result in the development of two products. These are modular and flexible systems, adaptable to many different applications. Image decides to focus its effort on image computer hardware and reusable software development, meaning that the products now consist only of three layers: hardware, system software, and reusable application software. Although in the start-up phase of these new products, Image decides to perform all different production steps itself, it is already foreseen at the time that, as the production level increases, assembly work will be done by subcontractors. Note that Image is only developing the vision subsystem, and not the parts manipulation system and interface between these two components, which together make up a total machine vision and handling system. Products are sold through four main channels: end users, OEMs, system integrators, and dedicated inspection systems manufacturers. Image's organizational structure at that time is horizontal, consisting of only two levels, with five managers reporting to the president. Image products are offered in 8 countries, and entry into 3 more countries is planned for 1984. Geographical target markets are the US and Europe. Entry into the US market is considered to be of the highest importance, since Europe lags 2 years behind on the US market.
The market for machine vision systems for automation purposes is rapidly growing and is expected to grow to ten times its current size within the next four years. However it is also highly fragmented: different industries with potential for different automation applications can be distinguished. It remains difficult to appraise the importance of different segments and to adequately identify customer needs and requirements, especially since there exists an educational gap with respect to customer awareness leading to are differences between early-adopters and the bulk of the market.
Although in the beginning of 1984, Image's end customers are situated in a broad range of sectors, the company plans for the years 1984-1985 to focus on three promising segments: the electrical/electronical/semiconductor industry, the automobile industry, and the pharmaceutical industry. In the long-run- that is as from 1987 - Image plans to narrow down its perspective even further to some key market segments and to start building entire inspection systems (including the parts manipulation systems and related engineering activities) for these key segments. The selection of these target markets will be based upon technical considerations and upon marketing factors.

In **October 1985**, a first core market is identified: the alignment and inspection on semiconductor and electronics assembly equipment. This core market is chosen based upon technical considerations and upon marketing factors. The niche consists of two sub-segments: semiconductor manufacturing and PC board manufacturing. Initially, electronics is seen as the main activity, but the semiconductor segment will later turn out to be the most important. Past experience has proven that system integrators and OEMs often did not fully understand Image's products and therefore did not succeed in integrating it successfully. In order to deal with this problem, Image decides to add additional layers to its new products, leading to system-level products consisting of product hardware, system software, algorithms, application software, and a system-level layer. Production is limited to assembly of printed circuit boards, electronic racks and to an extensive testing cycle. The rest is contracted out. Although its initial sales revenues came from broad range of activities, Image will now base its European growth mostly on the alignment and inspection on semiconductor and electronics assembly equipment. Frequent direct contacts with end-users and customers is necessary, and commercial contacts with OEMs will be controlled directly by Image from now on. Therefore the role of its European network of system integrators is redefined as being a distributors' network only. In the US all efforts will be targeted exclusively at alignment and inspection for electronics and semiconductor assembly industries. A fully owned subsidiary will be set up at the US West Coast. It will offer standard application packages, requiring only minor adaptations per customer, and offer these to OEM customers only. The subsidiary will run for a test period of two years. Both in the US and in Europe, main revenues will result from selling alignment and inspection systems for electronics and semiconductor assembly industries through OEM contracts. Siemens becomes one of the main OEM partners. In the European market, other machine vision systems for OEMs continue to constitute a minor part of sales.

**In 1986** a second possible target segment is identified, namely second optical inspection in the semiconductor industry. A prototype product is developed and exposed to users. These first market tests look promising and the plan is to prepare a marketing plan in fourth quarter of 1986. The selection criterion for this additional segment is that it should have sufficient technical and marketing synergy with the alignment and inspection segment. The plan for Image is to base its growth mostly on these two core markets.

During the **period 1985-1986**, there is an important growth of the European market for industrial vision machine systems. The US market is still dominant and substantial interest arises in Japan. However, the total market remains much segmented, based on the type of user industries, the types of applications, and the types of customers. A shake-out in the number of companies is expected in the coming years. Image tries to survive and overcome the segmentation problem by developing well-defined product offerings for core markets only. For these segments, it can clearly identify its customers and competitors. Image at that time, has developed a more elaborate organizational structure, consisting of three levels, with five managers reporting to the president. In addition to structured information flows, informal communication between all employees is explicitly encouraged during the whole period, in order to enhance mutual adjustments.

Somewhere between September 1986 and **October 1987**, the option of targeting second optical inspection in the semiconductor industry is dropped. Image focuses solely on alignment and inspection functions for electronics and semiconductor assembly equipment to enhance the level of automation. Both the subsegments of semiconductor manufacturing and of PC board manufacturing are targeted. Production is limited to the assembly of printed circuit boards and electronic racks, and to an extensive testing cycle. The rest is subcontracted. Both in the US and in Europe, main revenues result from selling alignment and inspection systems for electronics and semiconductor assembly industries through OEM contracts. In the European market, other machine vision systems for OEMs still constitute a minor part of sales. The Image subsidiary on the US West Coast has been set up. By October 1987, Image's organizational structure has changed slightly, with now four managers reporting to the president. The structure still consists of three levels (of which one represents the foreign subsidiary) and informal communication between all employees is still explicitly encouraged.

From **October 1988**, all revenues come exclusively from the target segment of alignment and inspection systems for electronics and semiconductor assembly industries through OEM contracts. Image has become one of the world leaders in this segment and has opened an Eastern Regional Support Office in Canton, Mass., US. to technically support local customers. Production is limited to the assembly preparation of printed circuit boards and electronic racks, and to an extensive testing cycle. The rest is subcontracted. A shake-out in the number of companies is taking place, as expected. Image's organizational structure has changed again slightly, with now three managers reporting to the president. The structure still consists of three levels and informal communication between all employees is still explicitly encouraged.

**In 1989**, a program for defining business opportunities in additional niches is set up. For these new opportunities both cooperation with existing outside partners and a natural expansion from present activities are investigated. The company investigates the option of lead coplanarity checking, for which P&P manufacturers already showed interest to Image in 1988. Gradually Image starts to realize that the biggest market was not P&P, but IC manufacturers.

**In 1990**, Image KK is established in Yokohama, Japan, as representative office. It distributes the Image OEM products in Japan and South Korea

**In 1991**, the company enters an additional new niche: developing and offering stand-alone inspection systems (complete system) for inspecting the position of the leads of SMD types of integrated circuits. These systems are offered directly to end-users via a distribution network. For this new market segment, Image has to establish partnerships for the development of the parts handling mechanism and of adequate distribution channels. It is unclear whether systems for integration or stand-alone systems will become most popular. Image decides to develop both. An international patent application is filed for the basic concept, i.e. the use of a dual shadow technique. By May 1992, the inspection part is fully developed and manual inspection systems start shipping to customers. For the fully automatic version however, the company still has to acquire some parts for the handling mechanism, of which Stanford Engineering is building a first prototype. All labor and process intensive part will be subcontracted, with Image personnel performing all quality assurance. For distribution, Image joins forces with DeContrade S.A. A sales network is set-up in Europe, in the US and in almost all Asian countries except for Japan. Image's Japanese subsidiary is doing a study of the local market. Various risks are related to this new market segment. The overall market size for lead inspection is only an estimate. There is no clear consensus on different competing technologies and the market is threatened by substitution; meaning that research in packages might solve the LCC problem, so that inspection would be no longer needed. Image is not known in this market and bears a risk by subcontracting the mechanical design, in which it has no experience. However, for stand-alone systems as well as for systems for integration, customers and competitors are known. Although actual sales are low, considerable growth is expected. The measurement set-up that is developed for this niche, is at the same time also offered to the OEM market, through the existing Image locations. Also the sales in Image's first segment, alignment and inspection functions for electronics and semiconductor assembly equipment to OEMs, continue to go through the existing channels. During recent years, the majority of vision companies has disappeared and those who survived are mostly niche players and well known to Image. Limited growth is expected in the OEM market. The major risk Image is running is related to the commercial success of its OEM customers in their markets.

## Appendix 1d: History of L-goritm

The idea to found L-goritm originates from a European project at the University of Leuven. The project is headed by Prof. K. and has five people working on it (a.o. Mr. DJ). There are a number of industrial partners involved in the project. However, they do not participate actively. **In 1995**, when the project runs out of funding, Mr. DJ - who has a master in mathematics and PhD degree - decides to found a spin-off and starts looking for a co-founder who could be responsible for the commercialisation. Mr. VC, who is working on a PhD in the same department, becomes co-founder of L-goritm.

At the **end of 1995**, L-goritm is thus founded as spin-off from the KUL. The initial intention of the company is to be a product company, delivering software for reverse engineering to a variety of sectors. However, during the early years (until the end of 1996) its main activities are offering services for quality control. These services are offered to local customers – often reached through university contacts - in a variety of sectors. During the whole **period 1995-1997**, L-goritm focuses on services to local customers and on R&D. L-goritm develops its service activities since these yield quick cash. Although L-goritm is working on the development of software for reverse engineering and realises its first sales in this area, the software for quality control is completed first, as support for L-goritm's service activities.

In these early years, Mr. VC is responsible for sales, engineering and after sales training and support. Mr. DJ is responsible for the mathematical technology. Neither of them has industrial or commercial experience. During the **period 1995-1996**, there are four people working at L-goritm, generating a revenue of 0,2 million €. **In the year 1997**, there are seven people working at L-goritm, generating 0,4 million € in revenue and a net loss of 0,1 million €. These increases in headcount mainly correspond to increases in R&D staff. During the first two years, a lot needs to be learned about technical aspects, applications, and sales. By the end of 1997, there is nothing left of the original technology as developed at the university.

At the **end of 1997**, an indirect dealer network is set-up for the distribution of reversed engineering software. Autodesk (CAD) dealers distribute the L-goritm software all over the world (incl. Taiwan, Korea, Singapore). The partnership with Autodesk allows L-goritm to learn about and to copy parts of their management and marketing know-how and strategy. Revenues increase, but the indirect approach proves to be less suited to build up reference accounts. This will lead to a change in the business model in 1998. In the mean time, L-goritm is still selling services for quality control in Belgium. Through hardware producers (especially producers of scanning material), L-goritm for the first time comes into contact with foreign automotive constructors. **In 1998**, the business model is extended to direct sales by setting up local commercial offices. In addition, R&D efforts are directed towards point cloud based verification instead of reverse engineering. However, there is still a lot of service activity. These changes result in very good financial results in 1998. The total number of people at L-goritm grows to twelve.

A take-over of a software company is planned, but is abandoned later on. From contacts with hardware producers (see above) and from its service activities, L-goritm has found firstly, that customers attribute a lot of value to the hardware, even though software is in reality the most important for total performance; and secondly, that hardware producers are in closer contact with the customer. Therefore, L-goritm decides to become active in hardware activities as well, since this will allow them to be in close contact with the customer, to offer a total solution, and therefore to reach the total available customer budget without having to negotiate with hardware producers on the division of the profit. **In 1999**, L-goritm acquires Measure GmbH, a German technology company, specialised in the development of optical measuring equipment. This makes complete product offering of SW and HW possible. In 1999, there are 22 people working for L-goritm. The company generates 2,1 million € revenues, - 0,4 million € EBITDA, and 1,7 million € net losses. **In 2000**, the management obtains a government loan to buy-out shareholders who had swapped shares in the acquisition of Measure GmbH. The acquired technology is gradually integrated, leading to a complete offering of software and sensors. Revenues continue to increase to 3,2 million €, resulting from both an increase in software and sensor business. The company is EBITDA break-even for the first time. There is a net loss of 0,8 million € and a headcount of thirty people. During the **period 1999-2000**, after the acquisition of Measure GmbH, it is decided to sell directly instead of through OEMs, to sell at higher prices, and to sell mainly to the US and Germany, thereby reducing geographical diversification.

By **medio 2001**, the development of standardised software products for verification is completed, and the automotive sector is chosen as main target segment. The first two quarters of 2001 show a 70% growth in revenue compared to the same quarters in 2000, and a positive net profit. The total headcount is 30.

**In 2002**, 6 million € are gathered in a financing round. L-goritm looks at the development of quality control for standard robots, decides not to continue with this idea, but keeps open the possibility for later re-evaluation. L-goritm does develop a specific solution for the niche of Co-ordinate Measurement Machines or CMMs. L-goritm's general direct sales approach is used towards reference customers and big customers, requiring special attention. Also customized new products (although always developed with the intention of turning them into a standard product later on) are sold through a direct approach. However, for the CMMs niche, L-goritm specifically opts for indirect sales through the CMM producers. This approach is very successful. An indirect sales approach through OEMs is thus re-introduced into the business model for the sales of mature products to the mass of the customers.

By the **spring of 2003**, L-goritm employs about 50 people and is selling products solely, with an 85% margin. The main focus is on quality control, with reverse engineering accounting for only 1,5 of 7 million €, and on the automotive sector. The standard product that is sold to the automotive sector, can also be used for and is also sold for other applications, s.a. in the aerospace and consumer goods sector. For the largest of these additional niches (s.a. turbines and mobile phones) L-goritm is currently developing specific modules.

**References**


Abernathy, W.J. and Utterback, J.M. 1975. A dynamic model of product and process innovation, *Omega* 3(6): 639-656.

Abernathy, W.J. 1978. *The productivity dilemma*. Baltimore, MD: The Johns Hopkins University Press.

Adizes, I. 1979. Organizational passages - diagnosing and treating lifecycle problems of organizations. *Organizational Dynamics* 8(1): 3-25.

Adizes, I. 1988. *Corporate lifecycles: how and why corporations grow and die and what to do about it.* Paramus, NJ: Prentice Hall.

Autio, E. 1997. Early growth and external relations in new technology-based firms. Paper presented at the ICSB conference, San Francisco, California, June 1997.

Autio, E., Sapienza, H.J. and Almeida, J.G. 2000. Effects of age at entry, knowledge intensity, and imitability on international growth. *Academy of Management Journal* 43(5): 909 – 924.

Bamford, C. E., Dean, T.J. and McDougall, P.P. 1999. An examination of the impact of initial founding conditions and decisions upon the performance of new bank start-ups. *Journal of Business Venturing* 15(3): 253-277.

Barron, D.N., West, E. and Hannan, M.T. 1994. A time to grow and a time to die: growth and mortality of credit unions in New York City, 1914-1990. *American Journal of Sociology* 100(2): 381-421.

Berry, M.M.J. and Taggart, J.H. 1998. Combining technology and corporate strategy in small high tech firms. *Research Policy* 26(7-8): 883-895.

Bhidé, A. 1992. Bootstrap finance: the art of start-ups. *Harvard Business Review* 70(6): 109-117.

Bhidé, A. 1996. The questions every entrepreneur must answer. *Harvard Business Review* 74(6): 121-130.

Bhidé, A. 2000. *The origin and evolution of new businesses*. NY, Oxford University Press.

Bijker, W.E. 1995. *Of bicycles, bakelites, and bulbs - Toward a theory of sociotechnical change*. Cambridge, MA: MIT Press.

Bijker, W.E. 1987. The social construction of Bakelite: toward a theory of invention. In. W.E. Bijker, T.P. Hughes and T.J. Pinch, eds., *The social construction of technological systems: new directions in the sociology and history of technology*. Cambridge, MA: MIT Press.

Brown, S.L. and Eisenhardt, K.M. 1995. Product development: past research, present findings, and future directions. *Academy of Management Review* 20(2): 343-378.

Brown, S.L. and Eisenhardt, K.M. 1997. The art of continuous change: linking complexity theory and time-paced evolution in relentlessly shifting organizations. *Administrative Science Quarterly* 42(1): 1-34.

Bruno, A.V., McQuarrie, E.F. and Torgrimson, C.G. 1992. The evolution of new technology ventures over 20 years: patterns of failure, merger, and survival. *Journal of Business Venturing* 7(4): 291-302.

Chapman, C.B. 1990. A risk engineering approach to project risk management. *International Journal of Project Management* 8(1): 5-16.

Chesbrough, H. 2003. The governance and performance of Xerox's technology spin-off companies. *Research Policy* 32(3): 403-421.

Chesbrough, H. and Rosenbloom, R.S. 2002. The role of the business model in capturing value from innovation: evidence from Xerox Corporation's technology spin-off companies. *Industrial and Corporate Change* 11(3): 529-555.

Churchill, N.C. and Lewis V.L. 1983. The five stages of small business growth. *Harvard Business Review* 61(3): 30-50.

Cooper, A.C., Gimeno-Gascon, F.J. and Woo C.Y. 1994. Initial human and financial capital as predictors of new venture performance. *Journal of Business Venturing* 9(5): 371-395.

Daft, R.L. and Lengel R.H. 1986. Organisational information requirements, media richness and structural design. *Management Science*, 32: 554-571.

Debackere, K. and Van Looy, B. 2003. Managing integrated design capabilities in new product design & development. In. B. Dankbaar, ed., *Innovation Management in the Knowledge Economy*. London: Imperial College Press.

DeBresson, C. and Amesse, F. 1991. Networks of innovators: a review and introduction to the issue. *Research Policy* 20(5): 363-379.

De Meyer, A., Loch, C.H. and Pich, M.T. 2002. Managing project uncertainty: from variation to chaos. *MIT Sloan Management Review* 43(2): 60-67.

Dosi, G. 1982. Technological paradigms and technological trajectories: a suggested interpretation of the determinants and directions of technical change. *Research Policy* 11(3): 147-162.

EC 1993. *The European observatory for SMEs: first annual report*. DG XXIII.

Eisenhardt, K.M. and Martin, J.A. 2000. Dynamic capabilities: what are they? *Strategic Management Journal* 21(10-11): 1105-1121.

Eisenhardt, K.M. and Schoonhoven C. 1990. Organisational growth: linking founding team, strategy, environment, and growth among U.S. Semiconductor Ventures, 1987-1988. *Administrative Science Quarterly* 35(3): 504-529.

Eisenhardt, K.M. 1989. Building theories from case study research. *Academy of Management Review* 14(4): 532-550.

Eisenhardt, K. M. and Tabrizi, B. N. 1995. Accelerating adaptive processes: product innovation in the global computer industry. *Administrative Science Quarterly* 40(1): 84 - 110.

Florida, R. and Kenney, M. 1990. Silicon Valley and Route 128 won't save us. *California Management Review* 33(1): 68-88.

Galbraith, J. R. 1977. *Organization design*. Reading, MA: Addison-Wesley Pub. Co.

Galbraith, J.R. 1982. Stages of growth. *Journal of Business Strategy* 3(4): 70-79.

Gersick, C. 1994. Pacing strategic change: the case of new venture. *Academy of Management Journal* 37(1): 9-45.

Hanks, S.H., Watson, C.J., Jansen, E. and Chandler, G.N. 1993. Tightening the life-cycle construct: a taxonomic study of growth stage in high-technology organizations. *Entrepreneurship: Theory and Practice* 18(2): 5-29.

Hannan, M.T. & Freeman, J. 1977. The Population Ecology of Organizations. *American Journal of Sociology* 82(5): 929-964.

Hansen, E.L. and Bird, B.J. 1997. The stages model of high tech venture founding: tried but true? *Entrepreneurship Theory and Practice* 2(4): 111-122.

Haveman, H.A. 1993a. Follow the leader: mimetic isomorphism and entry into new markets. *Administrative Science Quarterly* 38(4): 593-627.

Haveman, H.A. 1993b. Organizational size and change: diversification in the savings and loan industry after deregulation. *Administrative Science Quarterly* 38(1): 20-50.

Helfat, C.E. & Peteraf, M.A. 2003. The dynamic resource-based view: capability lifecycles. *Strategic Management Journal* 24(10): 997-1010.

Helfat, C.E. and Raubitschek, R.S. 2000. Product sequencing: co-evolution of knowledge, capabilities and products. *Strategic Management Journal* 21(10-11): 961-979.

Hite, J.M. and Hesterly, W.S. 2001. The evolution of firm networks: from emergence to early growth of the firm. *Strategic Management Journal* 22(3): 275-286.

Hymer, S.H. 1976. *A study of foreign direct investment*. Cambridge, MA: MIT Press.

Iansiti, M. 1995. Shooting the rapids: managing product development in turbulent environments. *California Management Review* 38(1): 37-58.

Janesick, V.J. 1994. The dance of qualitative research design. In: N.K. Denzin and Y.S. Lincoln, eds., *Handbook of Qualitative Research*. Thousand Oaks, CA: Sage.

Kazanjian, R.K., and Drazin, R. 1990. A stage-contingent model of design and growth for technology-based new ventures. *Journal of Business Venturing* 5(3): 137-150.

Kazanjian, R.K., and Drazin, R. 1989. An empirical test of a stage of growth progression model. *Management Science* 35(12): 1489-1503.

Lu, J.W. and Beamish, P.W. 2001. The internationalization and performance of SMEs. *Strategic Management Journal* 22(6-7): 565-586.

MacCormack, A. 1998. Towards a contingent model of product development: a comparative study of development practices. Paper presented at the 5th Conference on International Product Development Management, Italy, May 1998.

Miller, D. and Friesen, P.H. 1984. A longitudinal study of the corporate life cycle. *Management Science* 30(10): 1161-1183.

Mintzberg, H. and Quinn, B.J. 1991. *The strategy process: concepts, contexts, cases*. Englewood Cliffs, NJ: Prentice Hall.

Moore, G.A. 1999. *Crossing the chasm: marketing and selling high-tech products to mainstream customers*. Revised Edition, New York: Harper Business.

Moore, G.A. 1995. *Inside the tornado: marketing strategies from Silicon Valley's cutting edge*. New York: Harper Business.

Muzyka, D.F. and de Koning, A.J. 1996. Towards a theoretical model for adaptive entrepreneurial organisations using genetic algorithms. INSEAD-WP 96/85/ENT.

Nelson, B.R. and Winter, S.G. 1982. The Schumpeterian trade-off revisited. *American Economic Review* 72(1): 114-132.

Nicholls-Nixon, C.L., Cooper, A.C. and Woo, C.Y. 2000. Strategic experimentation: understanding change and performance in new ventures. *Journal of Business Venturing* 15(5-6): 493-521.

Pelz, D. C. and Andrews, F. M. 1966. *Scientists in organizations*. New York, NY: John Wiley & Sons.

Pich, M.T., Loch, C.H. and De Meyer, A. 2002. On uncertainty, ambiguity, and complexity in project management. *Management Science* 48(8): 1008-1023.

Reynolds, P. and Miller, B. 1992. New firm gestation: conception, birth, and implications for research. *Journal of Business Venturing* 7(5): 405-417.

Roure, J.B. and Keeley, R.H. 1990. Predictors of success in new technology based ventures. *Journal of Business Venturing* 5(4): 201-220.

Schrader, S., Riggs W. M. and Smith R. P. 1993. Choice over uncertainty and ambiguity in technical problem solving. *Journal of Engineering and Technology Management* 10(1-2): 73-99.

Shane, S. and Eckhardt, J. 2003. The individual-opportunity nexus. In: *Handbook of Entrepreneurship Research*, Z.J. Acs and D.B. Audretsch (eds.). Boston: Kluwer Academic Publishers: 161-191.

Shepherd, D.A., Douglas, E.J. and Shanley, M. 2000. New venture survival: ignorance, external shocks, and risk reduction strategies. *Journal of Business Venturing* 15(5-6): 393-410.

Singh, J.V. and Lumsden, C.J. 1990. Theory and Research in Organizational Ecology. *Annual Review of Sociology* 16: 161-195.

Smilor, R.W. and Gill, M.D. 1986. *The new business incubator; linking talent, technology, capital, and know-how*. Lexington, MA: Lexington Books.

Steensma, H.K., Marino, L., Weaver, K.M. and Dickson, P.H. 2000. The influence of national culture on the formation of technology alliances by entrepreneurial firms. *Academy of Management Journal* 43(5): 951-973.

Stevenson, H.H. and Gumpert, D.E. 1985. The heart of entrepreneurship. *Harvard Business Review* 63(2): 85- 94.

Stevenson, H.H., Roberts, M.J. and Grousbeck, H.I. 1989. *New business ventures and the entrepreneur*. Homewood, IL: Irwin.

Stinchcombe, A.L. 1965. Organizations and Social Structure. In: J. March, ed., *Handbook of Organizations*. Chicago, Ill: Rand McNally.

Suarez, F.F. and Utterback, J.M. 1995. Dominant designs and the survival of firms. *Strategic Management Journal* 16(6): 415-430.

Teece, D.J., Pisano and G. Shuen, A. 1997. Dynamic capabilities and strategic management. *Strategic Management Journal* 18(7): 509-533.

Tornatzky, L.G., Eveland, J.D., Boyland, M.G., Hetzner, W.A., Johnson, E.C., Roitman, D. and Schneider, J. 1983. *The process of technological innovation: reviewing the literature.* Washington, DC: National Science Foundation.

Tegarden, L.F., Hatfield, D.E. and Echols, A.E. 1999. Doomed from the start: what is the value of selecting a future dominant design? *Strategic Management Journal* 20(6): 495-518.

Teubal, M., Yinnon, T. and Zuscovitch, E. 1991. Networks and market creation. *Research Policy* 20(5): 381-392.

Thomke, S., von Hippel, E. and Franke, R. 1996. Modes of experimentation: an innovation process variable. Working Paper, Harvard Business School.

Thomke, S., von Hippel, E. and Franke, R. 1998. Modes of experimentation: an innovation process - and competitive – variable. *Research Policy* 27(3): 315-332.

Thomke, S. 2003. R&D comes to services. Bank of America's pathbreaking experiments. *Harvard Business Review* 81(4): 70-79.

Timmons, J. A. 1994. *New venture creation* (4th Edition). Homewood, IL: Irwin.

Utterback, J.M. 1994. *Mastering the dynamics of innovation: how companies can seize opportunities in the face of technological change.* Boston, MA: Harvard Business School Press.

Utterback, J.M. 1987. Innovation and industrial evolution in manufacturing industries. In. B. Guile and H. Brooks, eds., *Technology and global industry: companies and nations in the world economy.* Washington, DC: National Academy Press.

Van Looy, B., Debackere, K. and Bouwen, R. 2001. Innovation as a community spanning process: looking for interaction strategies to handle path dependency. In. G. Raghu and P. Karnoe, eds., *Path dependence and creation.* LEA Publishers.

Verganti, R., MacCormack, A. and Iansiti, M. 1998. Rapid learning in product development: an empirical study of the internet software industry. In. *Proceedings 5th International Product Development Management Conference, Como, Italy, 25-26 May.*

Vesper, K.H. 1990. *New venture strategies.* Englewood Cliffs, NJ: Prentice Hall.

Weick, K.E. 1979. *The social psychology of organizing.* Reading, MA: Addison-Wesley Pub. Co.

Wyer P. and Smallbone D. 1999. Export activity in SMEs: a framework for strategic analysis. *Journal of the Academy of Business Administration* 4(2): 9-24.

Yin, R.K. 1994. Case study research: design and methods. In: *Applied social research methods series 5.* Thousand Oaks, CA: Sage.